PENNSTATE ARL

iMAST QUARTERLY

Institute for Manufacturing and Sustainment Technologies

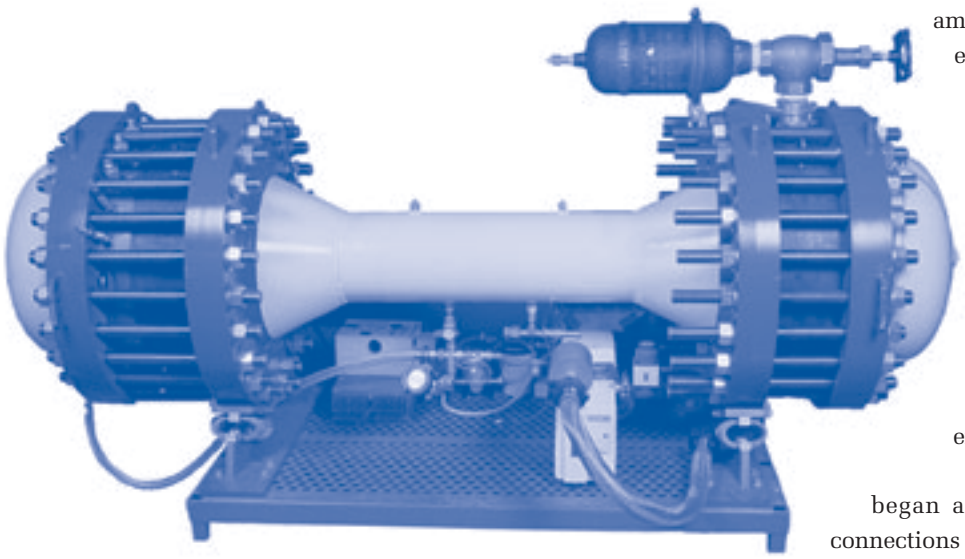
A U.S. Navy Manufacturing Technology Center of Excellence

2003 No.3

Sound Waves Send Chill Through ONR

Penn State Applied Research Lab engineers have produced a thermoacoustic refrigeration unit that has far-reaching implications for both Navy and Marine Corps weapon systems. Proof of concept has been achieved for a cooling devise that substitutes sound waves for environment-damaging chemical refrigerants. Refrigerants cause pollution. Chlorofluorocarbons (CFCs) once used in refrigeration units are long gone. While the new chemicals substituting for CFCs may not affect Earth's ozone layer, pollution problems still exist. Beyond the environmental aspect, the system also allows for unique design opportunities within limited space structures in such systems as ships and ground combat vehicles.

So how does the system work? The answer is noise; really loud noise readily generated aboard Navy and Marine Corps fighting machines. When inert gases are exposed to high-amplitude sound energy, a thermo-acoustic effect takes place. The refrigeration unit consists of a souped-up amplifier and a unit containing inert pressurized gases. High-volume sound hitting the inert gases in the freezer unit is enough to lower the temperatures to around minus-8 degree F.



According to Steve McElvany, a program manager within the Office of Naval Research, "The Navy has been looking for years for alternatives to freon-based cooling aboard Navy ships to save energy as well as the environment."

ARL researcher Steve Garrett notes, "What began as basic research on the fundamental connections between sound waves and heat transport, funded by the Office of Naval Research, is getting closer to providing an environmentally benign substitute for traditional engine and refrigeration technology."

In addition to funding by ONR, Ben & Jerry's Ice Cream (a division of Unilever) is also providing financial support. Technologies like thermoacoustic refrigeration are ideal for Navy ManTech implementation.

If you are interested in obtaining more information about this technology, contact Robert Keolian at <keolian@psu.edu> or call him at (814) 865-1365. For more information on other unique ARL technologies available for ManTech, contact iMAST's director, Bob Cook at <rbc5@psu.edu>, or call (814) 863-3880.

Focus On Repair Technology

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2003		**00-00-2003 to 00-00-2003**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
iMAST Quarterly, 2003 Number 3	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Penn State University,Applied Research Laboratory,Institute for Manufacturing and Sustainment Technologies,State College,PA,16804**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**8**	

PENNSTATE iMAST
Applied Research Laboratory
Institute for Manufacturing and Sustainment Technologies

DIRECTOR
Robert B. Cook
(814) 863-3880 rbc5@psu.edu

MATERIALS PROCESSING and DRIVETRAIN TECHNOLOGIES
Maurice F. Amateau, Ph.D.
(814) 863-4481 mfa1@psu.edu

LASER PROCESSING TECHNOLOGIES
Richard P. Martukanitz, Ph.D.
(814) 863-7282 rxm44@psu.edu

ADVANCED COMPOSITES MATERIALS TECHNOLOGIES
Kevin L. Koudela, Ph.D.
(814) 863-4351 klk121@psu.edu

MANUFACTURING SYSTEMS TECHNOLOGIES
Mark T. Traband, Ph.D.
(814) 865-3608 mtt1@psu.edu

COMPLEX SYSTEMS MONITORING
Karl M. Reichard, Ph.D.
(814) 863-7681 kmr5@psu.edu

NAVY/MARINE CORPS REPAIR TECHNOLOGIES
Sean L. Krieger
(814) 863-0896 slk22@psu.edu

iMAST ADMINISTRATOR and EDITOR
Gregory J. Johnson
(814) 865-8207 gjj1@psu.edu

STAFF ASSISTANT
Lori L. Mowery
(814) 865-3264 llm1@psu.edu

WORLD WIDE WEB
www.arl.psu.edu/centers/imast.html

NAVY PROGRAM MANAGER
John Carney
(703) 696-0352
carneyj@onr.navy.mil

IN THIS QUARTERLY

DIRECTOR'S CORNER

Change Continues

As we start the new fiscal year, change continues to impact the iMAST center. Our ONR program manager, James Mattern, has transferred to other responsibilities within the Naval Sea Systems Command. Jamie has been our ONR representative since before I assumed the job of director of iMAST. It is with regret that I bid him farewell, as he was instrumental in bringing some discipline to the process and providing necessary communication links to the implementation segment of the Navy ManTech program.

As we enter the fiscal year, the budget picture has become clearer. The iMAST center will focus the bulk of its effort on projects associated with the CVN 21, the next generation carrier. We will be working in close coordination with the NAVSEA Program Office, Northrop Grumman Newport News Shipbuilding, and the ONR ManTech Carrier representative, John Carney.

This newsletter's feature article focuses on Surface Preparation Improvement, a vital link in fighting corrosion. Charlie Tricou, the principal investigator, previously worked with Marine Corps Logistic Base personnel to solve a paint stripping problem at the base. Proper surface preparation is necessary if paint application is to be effective. Since the Government Accounting Office recently reported that corrosion costs the military more than $20 billion annually, the problem affecting the fleet is enormous and merits close attention. As our fleet ages and operational tempo grows, corrosion issues will only become more important.

There are several technologies resident at ARL that combat corrosion. Charlie Tricou specializes in paint application technology also, and has identified technologies that essentially eliminate paint overspray. He also is an expert on spray metal application. Other technologies include High Velocity Particle Consolidation (HVPC), which has been used to apply a corrosion coating to Amphibious Assault Vehicle (AAV) armor appliqué kits. We are currently testing our efforts on a Marine Expeditionary Unit deployment. Another process we are evaluating is laser cladding with corrosion resistant alloys. This results in a layer with low dilution of the base metals into the cladding, and minimum distortion of the base surface. This technology is being used to solve a corrosion challenge on vertical launch tubes of Los Angeles class submarines.

As the new fiscal year kicks off, I am excited with the prospects for the coming year. I encourage you all to talk to our experts. Together, we can help solve the challenges facing our Navy and Marine Corps team.

Bob Cook

PENNSTATE iMAST

- MATERIALS PROCESSING TECHNOLOGIES
- MECHANICAL DRIVE TRANSMISSION TECHNOLOGIES
- LASER PROCESSING TECHNOLOGIES
- COMPLEX SYSTEMS MONITORING TECHNOLOGIES
- ADVANCED COMPOSITES MATERIALS TECHNOLOGIES
- NAVY/MARINE CORPS REPAIR TECHNOLOGIES
- MANUFACTURING SYSTEMS TECHNOLOGIES

Focus on Repair Technology

Surface Preparation Improvement: Chemical Paint Remover Evaluation for Marine Corps Logistics Base (MCLB) Albany

by Charlie S. Tricou

Background

The Applied Research Laboratory was approached by MCLB Albany to investigate and identify a viable chemical paint removal process for small parts paint removal. The Albany depot had previously installed an n-methyl pyrrolidone (NMP) chemical paint stripping system to replace their methylene chloride process. Unfortunately, water from the humid Albany environment was absorbed by the chemical stripping solution, substantially reducing its effectiveness. Maintaining the cleanliness and effectiveness of the stripping solution is burdensome and therefore not an effective chemical stripping process at the Albany MCLB. The NMP paint stripping facility had fallen into disuse and paint removal on small components was performed using abrasive blasting.

Glass bead, plastic media or other "non-aggressive" abrasives have often been used in lieu of chemical stripping. Abrasive blasting, however, is labor-intensive, may damage sensitive substrates and often produces a hazardous solid waste stream due to the presence of cadmium and chrome on plated components.

Approach

In consultation with Albany MCLB paint shop personnel, a list of the paint types encountered during USMC maintenance was created. These coatings include:

- Chemical Agent Resistant Coatings (CARC) (solvent-borne, water-borne)
- Sea-Foam Green solvent-borne epoxy
- Sherwin-Williams epoxy powder coatings

Initially, six (6) candidate chemical strippers were selected for evaluation at two processing temperatures (room temperature and 150°F). Elevated temperature tests were performed first. Chemical strippers that were ineffective at 150°F were eliminated from subsequent testing. The percentage of removal was estimated at discrete time intervals, up to a maximum of 24 hours.

Experimental

Test panels and component samples were received from the Albany Marine Corps Logistics Base (MCLB) depot. In addition to the older solvent-based CARC coatings and sea-foam green epoxy coatings commonly in use, Albany suggested that the newer water-based CARC coatings and a Sherwin-Williams epoxy powder coating under evaluation also be included in the test matrix. This proactive approach proved valuable in identifying a long-term chemical stripping solution for the Albany MCLB depot.

The six chemical stripping solutions evaluated are described in Table 1.

Supplier	Stripper	Composition
OAKITE	Guardostrip Q7900A	40–50% Trade secret alcohol 5–10% Trade secret surfactant 5–10% Trade secret organic acid 1–5% Trade secret surfactant 1–5% Sodium lauryl sulfate 20–48% Non-hazardous ingredients
Atofina	TURCO 6776 Thin	35–65% Water 10–20% Benzyl alcohol 10–15% Formic acid 10–15% Sodium xylene sulfonate 10–15% Hydrotreated petroleum distillates
Atofina	TURCO 4181L	65–75% Water 20–30% Sodium hydroxide 5–10% Triethanolamine 5–10% Sodium gluconate
Atofina	TURCO 5668	40–50% N-Methyl-2-pyrrolidone 25–35% Ethanolamine 10–20% Hydrotreated petroleum distillates 5–10% Toluene sulfonamide mixture <5% Potassium hydroxide
Atofina	TURCO 6877	55–65% Water 10–30% Benzyl alcohol 1–10% Formic acid 1–10% Benzyl formate <5% d-Limonene
N/A	Hydrogen Peroxide	15% and 30% in water

Table 1. Composition of chemical strippers.

PROFILE

Mr. Tricou is an Associate Research Engineer at ARL Penn State. Mr. Tricou manages projects involving paint application and removal for maintenance and repair of DoD assets, and new construction in shipbuilding. His current projects involve development of high transfer efficiency painting processes, measurement of flash rust and the prediction of subsequent coating performance, and development of long-life nonskid flight deck coating systems.

Mr. Tricou earned a B.S. in engineering science and mechanics, and an M.S. in theoretical and applied mechanics at the University of Illinois at Urbana-Champaign, where he studied material design and analysis, with a minor in computer applications. Mr. Tricou can be reached at (814) 863-4459, or by e-mail at <Tricou@psu.edu>.

Test panels were prepared and cut into 2" × 6" strips. For the sea-foam green coating trials, actual pieces of vehicle parts were received and cut into sizes suitable for laboratory paint stripping trials. Newly prepared solvent-based CARC panels and solvent-based CARC samples from retired components were also evaluated. To enable accurate comparisons between paint strippers, the newly applied solvent-borne CARC (Bag 1) and aged solvent-borne CARC (Bag 2) were treated as different coatings. Likewise, water-borne CARC panels from two separate suppliers were also treated as different coatings. These test samples were designated "Thin" and "Thick" based on the thickness of the test panel on which the coatings were applied.

EXPERIMENTAL DESIGN

All coating types were first evaluated at 150°F as a screening test. Any stripper found to be ineffective at the elevated temperature was eliminated from further testing. After some initial experiments, a 1.5 hour dwell time in the stripping solution was found to be useful in differentiating between the various chemical strippers.

Following the elevated temperature screening tests, the room temperature tests were conducted. Samples were evaluated at 5 hours and 24 hours. For the two strippers that were found to be the most effective, triplicate runs were performed to establish process variability. The two most effective paint strippers were then evaluated for use on vehicle parts with intricate geometries.

Test results were recorded, and photographs were taken of all samples at appropriate time periods. The amount of paint removed on each side of the part was estimated by visual inspection. Removal effectiveness was recorded as a percentage of the coating removed, and the removal percentages on each side of the test panel were averaged and the average recorded as an overall removal percentage.

Results and Discussion

The results are presented in Table 2. Stripping effectiveness of the two most effective chemical strippers are shown in Figure 1. In Figure 1, each horizontal line represents a single trial. Lines extending to the far right of the graph represent high removal percentages. Medium gray lines represent the 150°F screening tests. Ideally, we want maximum stripping effectiveness on all coating types at room temperature and short dwell times. This would be depicted by all dark gray lines extending to the far right side of the graph for all coating types.

COMPARISON OF OAKITE 7900A AND TURCO 6776 THIN

Under the conditions of this testing and with the 6 part types provided for the test

Table 2. Tabular summary of all paint stripping test results.

			% of Coating Removed*																	
			Seafoam Green			Powder Coat			Solvent CARC Bag 1			Solvent CARC Bag 2			Water CARC Thick Plate			Water CARC Thin Plate		
Chemical Stripper	Temp (F)	Run #	2 hrs	5 hrs	24 hrs	2 hrs	5 hrs	24 hrs	2 hrs	5 hrs	24 hrs	2 hrs	5 hrs	24 hrs	2 hrs	5 hrs	24 hrs	2 hrs	5 hrs	24 hrs
TURCO 4181L	150	1	0	---	---	0	---	---	---	---	---	0	---	---	0	---	---	---	---	---
TURCO 6877	150	1	98	---	---	85	---	---	---	---	---	90	---	---	98	---	---	---	---	---
TURCO 5668	150	1	---	98	98	---	98	98	---	---	---	---	10	65	---	25	40	---	---	---
	RT	1	---	0	95	---	5	15	---	---	---	---	0	5	---	0	5	---	---	---
Hydrogen Peroxide, 15%	150	1	0	---	---	0	---	---	---	---	---	0	---	---	---	---	---	98	---	---
Hydrogen Peroxide, 30%	RT	1	---	0	0	---	0	0	---	---	---	---	0	2	---	0	98	---	---	---
Oakite Q7900A	150	1	40	---	---	100	---	---	---	---	---	100	---	---	100	---	---	---	---	---
	RT	1	---	75	100	---	5	100	---	5	40	---	60	100	---	0	100	---	20	85
	RT	2	---	0	35	---	65	70	---	5	40	---	95	EC-R	---	0	30	---	0	100
	RT	3	---	15	80	---	15	100	---	5	40	---	100	EC-R	---	5	55	---	30	95
	RT	Complex parts	---	0	80	---	---	---	---	---	---	---	45	50	---	---	---	---	---	---
TURCO 6776 Thin	150	1	95	---	---	100	---	---	100	---	---	---	---	---	---	---	---	100	---	---
	RT	1	---	95	EC-R	---	100	EC-R	---	5	70	---	100	EC-R	---	99	EC-R	---	10	60
	RT	2	---	95	100	---	60	60	---	20	80	---	100	EC-R	---	100	EC-R	---	0	20
	RT	3	---	50	75	---	65	100	---	40	60	---	100	EC-R	---	98	EC-R	---	5	90
	RT	Complex parts	---	95	EC-R	---	---	---	---	---	---	---	45	50	---	---	---	---	---	---

* Percent removed is the average of visual inspection of all sides of the part.
** Times are approximate to simplify representation in the table. For example, a point designated as 2 hours in the table may actually be 1.5 hours.
'EC-R' = Essentially Complete at earlier time interval, Removed from bath.

(2 solvent-borne and 2 water-borne CARC), the TURCO 6776 Thin stripper outperforms the Oakite Guardostrip 7900A stripper. TURCO 6776 Thin is more effective at stripping five of the coating types in 5 hours. This may be seen by noting how much more dark gray (5 hours) is present in the TURCO 6776 Thin graph than is present in the Oakite 7900A graph. TURCO 6776 Thin is also much more effective than Oakite 7900A at stripping sea-foam green. In addition, where TURCO 6776 Thin was ineffective at room temperature (Thin water-borne CARC), it became 100% effective at 150°F.

Two parts having complex geometry were tested in both Oakite 7900A and TURCO 6776 Thin at room temperature. Both strippers removed most of the solvent-borne CARC coating in 5 hours at room temperature. On one side of the part, with both strippers, a small amount of coating remained in the anchor pattern created by blasting of the substrate; the other side of the part was smooth and 100% of the coating was removed (Figure 2).

TURCO 6776 Thin removed about 95% of the sea-foam green coating from the irregular part in 5 hours, while Oakite 7900A removed only about 60% of the coating in 24 hours at room temperature (Figure 2).

This test program, and the cooperation between the depot, logistics center, and Penn State ARL enabled the depot at MCLB Albany to identify the single-most environmentally acceptable and effective paint remover for current and future coatings that will be encountered during repair operations. As a direct result of this program, the MCLB Albany has designed, and is in the process of building, a dedicated paint stripping facility. This paint stripping facility will house three basic paint stripping lines, the largest of which will accommodate parts up to 8' × 10' × 54" deep. Within this facility, MCLB Albany has also installed an additional small paint stripping line to allow the depot to perform production studies on current and future paint removal formulations and coatings.

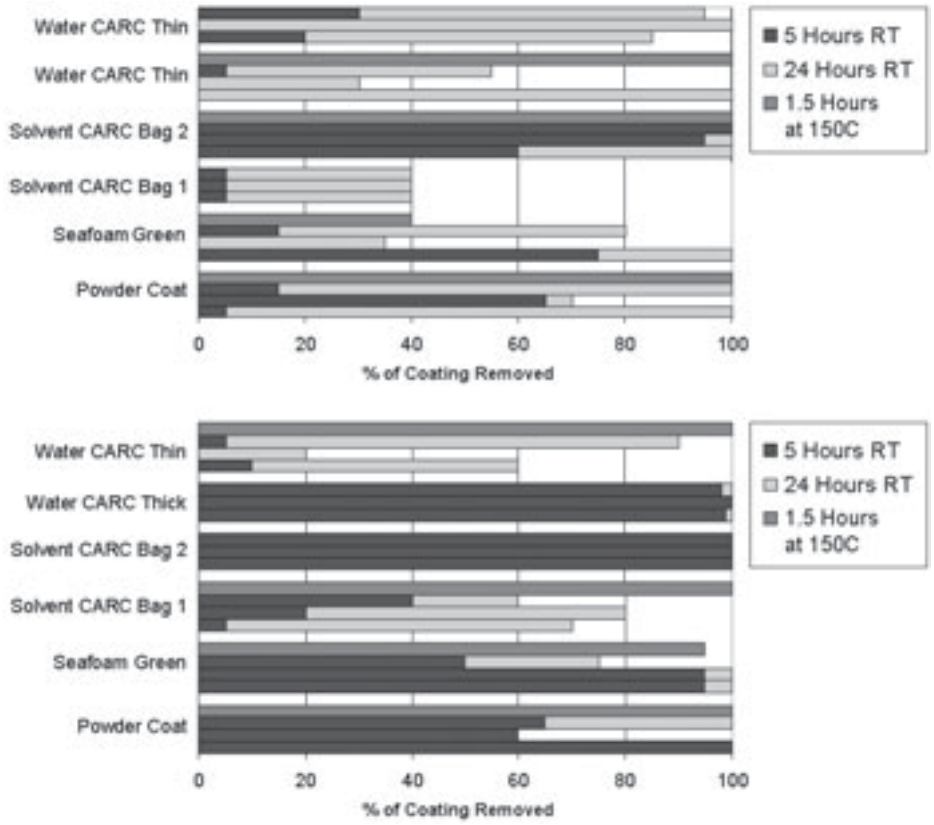


Figure 1. Comparison of stripping effectiveness of Oakite Guardostrip Q7900A with agitation (top) and TURCO 6776 Thin with agitation (bottom).

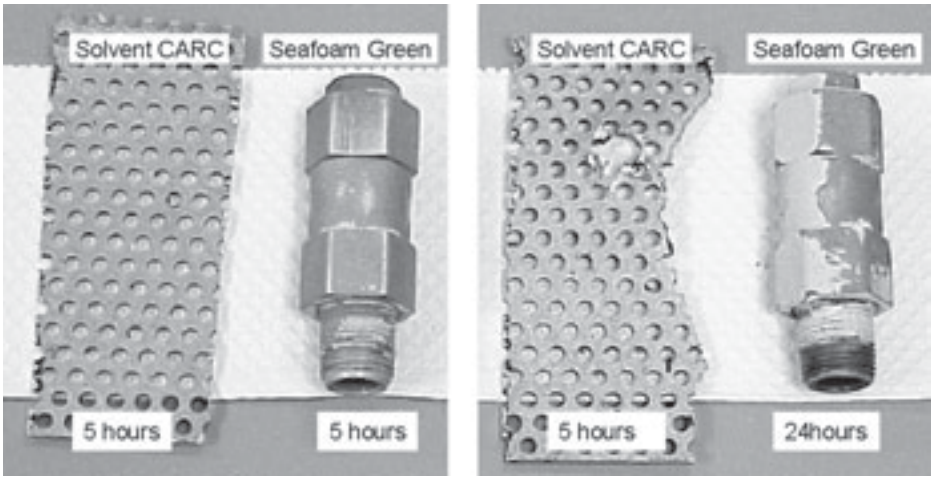


Figure 2. Parts with complex geometry, stripped with TURCO 6776 Thin (left) and Oakite Q7900A (right), at room temperature. Note the unstripped paint in the right photo.

About the Maintenance Center at MCLB Albany

The Maintenance Center at Marine Corps Logistics Base (MCLB) at Albany, GA, comprises a depot maintenance complex that provides worldwide expeditionary logistics support to the Fleet Marine Force (FMF), other forces, and agencies.

The repair facility operates as a multi-commodity maintenance center. The Maintenance Center (MC) is an integral part of the Marine Corps Logistics Base, and works closely with the other organizations in carrying out the mission of the base, which is to provide logistics support to Marine

Forces that will maintain continuous readiness and sustainment necessary to meet operational requirements.

The Marine Corps Maintenance Center is capable of supporting Marine Corps ground combat and combat support equipment as well as other customers with similar needs. Personnel are cross-trained to apply common skills to work on a variety of equipment in different commodities. This affords the Marine Corps MCs the flexibility to rapidly realign their work force to meet the changing requirements of the FMF and other customers. It should be noted that while the MCs' capacity for each major commodity is highly flexible, their total capacity is relatively constant.

The mission of the Maintenance Center at MCLB Albany is to:

- Repair, rebuild, and modify all types of Marine Corps ground combat equipment, and combat support and combat service support equipment.
- Provide Inspect and Repair Only as necessary on all Marine Corps equipment.
- Provide preparation for shipment and care-in-store support to the remote storage activity.
- Provide calibration support to various Marine Corps customers.
- Conduct special projects as directed.

MCLB Albany was established on 1 February 1954 as the Repair Branch, Marine Corps Supply Center, Albany, Georgia. Production began on 1 October 1954. In July of 1968 the division became an Industrial Fund Activity (IFA) operating under private sector principles and practices.

Major End Items include:

- AAV - Assault Amphibious Vehicle
- LAV - Light Armored Vehicle
- M1A1 - Main Battle Tank
- HMMWV - High Mobility Multi-Purpose Wheeled Vehicle
- M88 - Recovery Vehicle, Tracked
- Trucks, Various Types
- LVS - Logistics Vehicle System (MK48 and Trailers)
- M9 ACE -Armored Combat Earthmover

The Maintenance Center at the Marine Corps Logistics Base in Albany, Georgia.

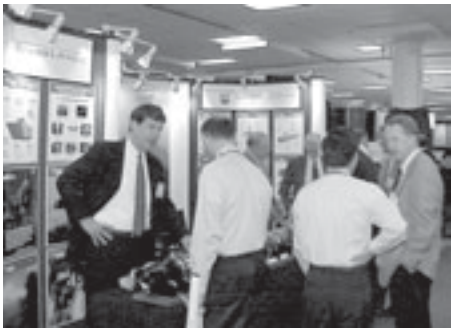
- M970 Fuel Tanker
- AVLB - Armored Vehicle Launched Bridge

The Maintenance Center works all types of military ordnance, motor transport, engineering, general purpose, electronic, and communication equipment. This includes major end items and various secondary depot repairable components. MCLB Albany is located 176 miles south of Atlanta, Georgia. The Maintenance Center consists of 48 buildings with 852,400 square feet. The main building is 362,000 square feet with one 75- and two 30-ton overhead cranes. The current work force is composed of 723 civilians and 6 Marines. The Maintenance Center has an annual payroll of approximately $45.8M for the civilian work force and $303K for military.

The Maintenance Center has a very active environmental staff that consists of four environmental protection specialists and three hazardous material handlers. In addition, each cost work center has a representative assigned to coordinate the daily generation of waste and use of materials. A base environmental office fully staffed with complete multimedia accountability complements the staff of the Maintenance Center. Every year complete refresher training is provided to the environmental staff as well as the individual cost work center representatives. In addition awareness training is provided to all industrial employees within the Maintenance Center who have the opportunity to cause the Center to become out of compliance. All industrial effluent from the Maintenance Center is discharged to the City of Albany municipal wastewater treatment works and the city maintains surveillance of the parameters of the wastewater discharge permit. The MCLB has good relations with local, state, and federal environmental agencies. The Maintenance Center maintains a pre-treatment industrial waste water treatment plant, and recovers/recycles used fuels, oils, and antifreeze.

Planned enhancements for repair techniques/processes include: construction of chemical stripping facility, construction of conversion coating facility, construction of two large clearspans, 5-axis water jet cutting machine with 20-foot bed, transmission dynamometer upgrade to support new vehicles, engine dynamometer upgrade to support new vehicles, upgrade radiographic equipment and facilities, and renovation of small arms shop.

For more information about MCLB Albany, visit their web site at: <http://www.ala.usmc.mil/>



iMAST Director Bob Cook (left) and Associate Director for Materials and Manufacturing, Tom Donnellan (right) discuss various programs with booth visitors.

Admiral Frank Bowman, USN is briefed on ARL Penn State's anti-torpedo torpedo (ATT) at the Navy League Expo.

Lorri Bennett, Gary Stump, and Mike Yukish

Navy League Expo 2003

The recent annual Navy League Sea-Air-Space Expo held in Washington D.C. provided a great forum to promote ARL's Navy ManTech program. Significant industry participation drew large numbers of Navy and Marine Corps officials. This year's theme, "America's Best", focused on innovative systems designed to advance America's military superiority. Since 1902, the Navy League has been educating Americans on the need for sea power, on and under the sea, in the air, and out in space. The annual exposition provides a forum for sea service professionals and the defense industry to come together. iMAST's participation provides yet another outreach forum for the U.S. Navy ManTech Program at Penn State's Applied Research Laboratory. Be sure to mark your calendars for next year's event which will be held in Washington, D.C. 6-8 April 2004.

AIAA Honors Bennett, Stump and Yukish

The American Institute of Aeronautics and Astronautics (AIAA) recently recognized ARL's Lorri Bennett, Gary Stump, and Mike Yukish with a Best Paper Honorable Mention award for their 9th Symposium on Multidisciplinary Analysis and Optimization paper submission titled "Multidimensional Visualization and its Application to a Design by Shopping Paradigm." Of the 247 papers presented, 32 were chosen as finalist for this award. Of those 32 papers, ARL's paper was considered one of the top eight.

With more than 31,000 members, the American Institute of Aeronautics and Astronautics (AIAA) has been the principal society of the aerospace engineer and scientist. Officially formed in 1963 through a merger of the American Rocket Society (ARS) and the Institute of Aerospace Sciences (IAS), the purpose was, and still is, "to advance the arts, sciences, and technology of aeronautics and astronautics, and to promote the professionalism of those engaged in these pursuits." Both ARS and IAS brought to the relationship a long and eventful history stretching back to 1930 and 1932, respectively—and each left its mark on the Institute. The merger combined the imaginative, opportunistic, and risk-taking desire of those rocket, missile, and space professionals with the more established, well-recognized achievers from the aviation community.

Since publishing the first edition of the American Interplanetary Society's monthly Bulletin in June 1930, AIAA has earned an international reputation as the primary publisher of innovative aerospace literature, and the top resource for tapping into the industry's archives, dating back to the early 1900s. Over the past 65 years, AIAA and its predecessor organizations have published more than 350 books and 250,000 technical papers. Current publications include six journals, two magazines, more than 40 standards, an increasing number of electronic products, and a Web site.

The AIAA's Multidisciplinary Design Optimization (MDO) technical committee works to provide an AIAA forum for those active in development, application, and teaching of a formal design methodology based on the integration of disciplinary analyses and sensitivity analyses, optimization, and artificial intelligence, applicable at all stages of the multidisciplinary design of aerospace systems.

iMAST congratulates Lorri Bennett, Gary Stump and Mike Yukish for a job well done.

CALENDAR OF EVENTS

17–20 Nov.	ASME Mechanical Engineering Congress			Washington, D.C.
18–19 Nov.	Fleet Maintenance Symposium			Virginia Beach, VA
1–4 Dec.	Defense Manufacturing Conference 2003	□□□□□□□	*visit the iMAST booth*	Washington, D.C.
2004				
Jan. TBA	ShipTech 2004	□□□□□□□	*visit the iMAST exhibit table*	TBA
3–5 Feb.	U.S. Naval Institute West 2004 Technology Expo			San Diego, CA
6–8 Apr.	Navy League Expo	□□□□□□□	*visit the iMAST booth*	Washington, D.C.
Apr. TBA	TechTrends 2004	□□□□□□□	*visit the iMAST booth*	Pittsburgh, PA
May TBA	Johnstown Showcase for Commerce	□□□□□□□	*visit the iMAST booth*	Johnstown, PA
May TBA	USCG Innovation Expo			Baltimore, MD
8–10 June	American Helicopter Society Forum	□□□□□□□	*visit the iMAST booth*	Baltimore, MD
Sep. TBA	Marine Corps League Expo	□□□□□□□	*visit the iMAST booth*	Quantico, VA

Quotable

"It costs a lot to build bad products."
—Norm Augustine, CEO Lockheed Martin Corporation

PENNSTATE
1855
Applied Research Laboratory□
P.O. Box 30□
State College, PA 16804–0030

ADDRESS CORRECTION REQUESTED